Reactions of 2,3-Bishydroxyimino-1,2,3,4-tetrahydroquinoxalines and 2,3-Bishydroxyimino-2,3-dihydro-4*H*-1,4-benzoxazines with Ethyl Chloroformate

Evangelia A. Varella and Demetrios N. Nicolaides

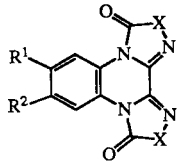
Department of Chemistry, Aristotelian University of Thessaloniki,
54006 Thessaloniki, Greece

June 12, 1990

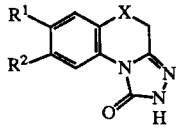
Bishydroxyiminoquinoxalines **3a-b** react with ethyl chloroformate **4** to afford the furazano[3,4-*b*]quinoxalines **5a-b**. Bishydroxyiminobenzoxazines **6a-c** on treatment with **4** are converted into the fused oxadiazolones **7a-c** and **8a-c** along with the bisethoxycarbonyloxyimino-derivatives **9a-c**. From the reactions of **4** with the oxanilide dioximes **12a-c** compounds **13a-c** and **14a-b** are obtained.

J. Heterocyclic Chem., **28**, 311 (1991).

It is known that *N*-alkyl or *N*-aryl amidoximes react with ethyl chloroformate **4** to give *O*-ethoxycarbonyl derivatives, which by further lactamization and subsequent ethanol elimination afford the corresponding Δ^2-1,2,4-oxadiazolin-5-ones [1-3]. The preparation of two 3,3'-bis(4-aryl-1,2,4-oxadiazol-5-ones) **14** (R = H or 4-CH_3-) by treatment of the corresponding bis-amidoximes **12** with **4** has also been reported [4]. The title quinoxaline and benzoxazine derivatives can be considered as bis- and mono-amidoximes respectively. Although these compounds are known and can easily be prepared by treating *o*-phenylenediamines or, for the second case, *o*-aminophenols with cyanogen di-*N*-oxide [5], their behaviour in reactions with **4** has not yet been studied. Recently Sastry *et al.* reported the synthesis of some ditriazoloquinoxalinediones **1** (X = NH), triazolobenzoxazinones **2** (X = O) and benzothiazinones **2** (X = S) by further cyclisation-ethanol elimination of the corresponding 2,3-bis-ethoxycarbonylhydrazono-1,2,3,4-tetrahydroquinoxalines and 3-ethoxycarbonylhydrazono-2,3-dihydro-4*H*-1,4-benz (ox or thi) azines respectively [6,7]. These fused 1,2,4-triazolo derivatives were found to possess very interesting biological activities.



1

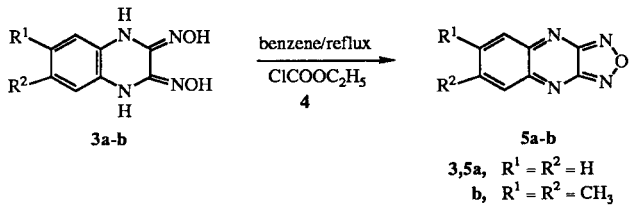


2

In connection with our previous work on the synthesis of the title amidoximes [5] and on the oxidative transformation of the quinoxalines to furoxano[3,4-*b*]quinoxalines [8], we now wish to report our results on the title reactions, as well as on those of compound **4** with the oxanilide dioximes **12a-c**. The reactions studied and the products obtained are depicted in Schemes 1-3.

The reaction of 2,3-bishydroxyimino-1,2,3,4-tetrahydroquinoxalines **3a-b** with ethyl chloroformate **4** (Scheme 1) did not afford the corresponding *O*-ethoxycarbonyl-derivatives neither the fused 1,2,4-oxadiazolones **1** (X = O) expected. Instead refluxing **3a-b** in dry benzene with an excess of **4** over 1.5 hours led solely to the known [8,9] furazano[3,4-*b*]quinoxalines **5a-b** in 18% and 27% yield respectively, along with an unidentified compound, not melting up to 325° and insoluble in ether. When the reaction was repeated by using an even larger excess of compound **4** and by extending the reaction time up to 6 hours, compound **5a** was obtained in 47% yield along with the same unidentified by-product. Obviously more evidence is necessary to explain thoroughly the reactions discussed above.

Scheme 1

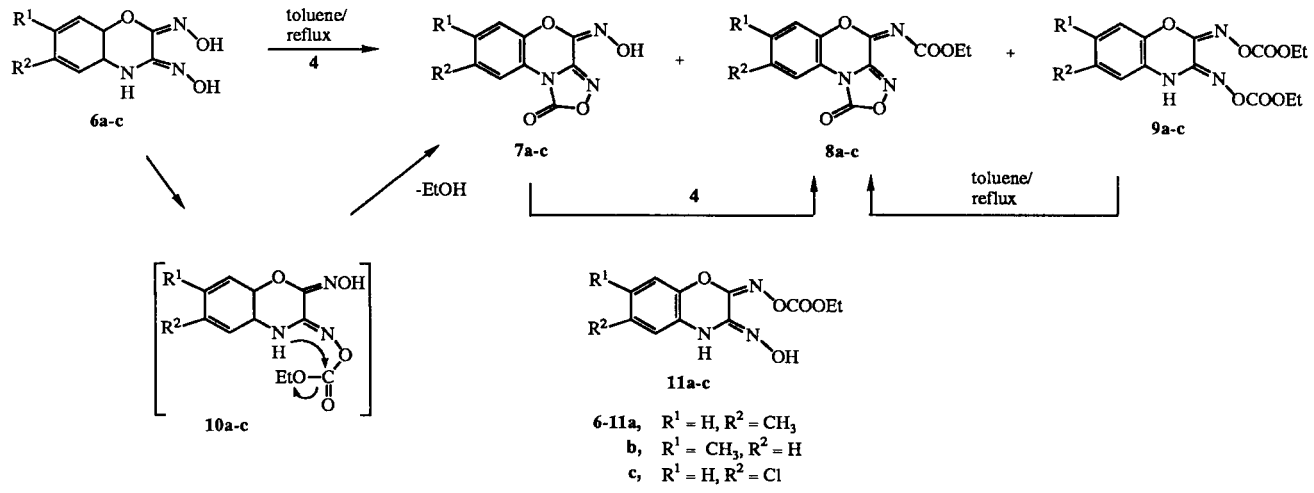


3a-b → **5a-b**

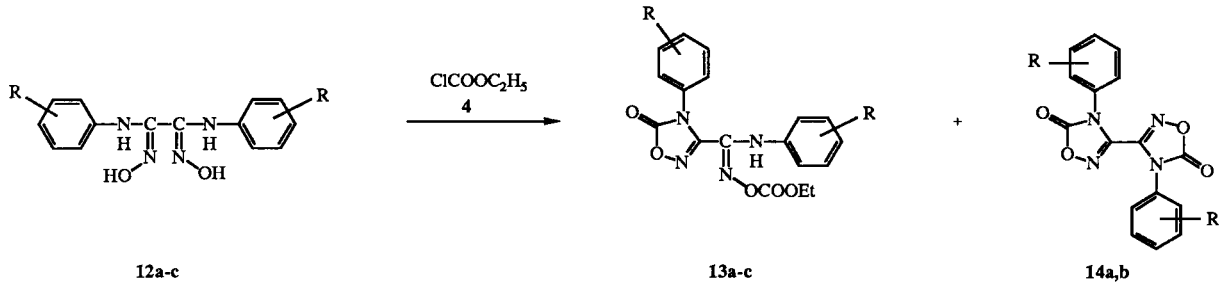
3,5a, $R^1 = R^2 = H$
b, $R^1 = R^2 = CH_3$

In a parallel project we paid attention to the reactions of 2,3-bishydroxyimino-2,3-dihydro-4*H*-1,4-benzoxazines **6a-c** with **4** (Scheme 2). These were carried out in refluxing toluene by using a slight excess of ethyl chloroformate **4** in order to examine the reactivity of the two differenciated hydroxyimino groups towards the electrophile **4**. By treating compound **6a** with an 1:1.2 ratio of **4** in refluxing toluene for 3 hours and separating the reaction mixture by column chromatography, 8-methyl-4-hydroxyimino-1*H*,4*H*-[1,2,4]oxadiazolo[3,4-*c*][1,4]benzoxazin-1-one **7a**, 8-methyl-4-ethoxycarbonyloxyimino-1*H*,4*H*-[1,2,4]oxadiazolo[3,4-*c*]-[1,4]benzoxazin-1-one **8a**, as well as 6-methyl-2,3-bis(ethoxycarbonyloxyimino)-2,3-dihydro-4*H*-1,4-benzoxazine **9a** in 16%, 18% and 22% yields respectively were obtained, whereas the reaction of **6b** or **6c** with ethyl chloroformate **4** afforded compounds **7b** (15%), **8b** (23%) and **9b** (14%), or **7c** (19%), **8c** (16%) and **9c** (19%).

Scheme 2



Scheme 3



Obviously compounds **7** were formed by further lactamization of the non isolated intermediate **10**, what means that under the experimental conditions applied, the transformation **10** → **7** can easily proceed, probably due to the *Z*-configuration of the ethoxycarbonyloxyimino group in **10**. Compounds **8** can be formed by further ethoxycarbonylation of compounds **7** and also by the subsequent ethanol elimination-lactamization of compounds **9**, as it was found out by performing the following control experiments. Treatment of **7b** with **4** afforded compound **8b** in 33% yield. The same product **8b** (46%) was also obtained by refluxing a toluene solution of **9b** for 4 hours. It should be noticed that the ethoxycarbonyl-derivatives **11** were in no case isolated from the reactions studied.

The lower activity of the hydroxyimino group neighbouring to the oxygen in 1,4-benzoxazines **6a-c** can be explained by assuming that they adopt the amphi-configuration depicted in Scheme 2 and hence exhibit a steric hindrance towards the approach of **4** to the hydroxyimino group under question. Recently Gök and Serin [10] reported the synthesis of 2,3-bishydroxyimino-2,3-dihydro-4*H*-1,4-benzothiazine by treatment of *o*-aminothiophenol with cyanogen di-*N*-oxide and suggested for the sole isomer obtained an amphi-configuration, opposite to that proposed for compounds **6a-c**. The latter were used in the reactions studied in a single isomeric form as it was indicated by their ^{1}H nmr spectra (recorded in DMSO-d_6 solutions). Thus, compound **6a** showed three absorptions at δ 9.58 (N-H), 10.58 (O-H) and 10.67 (O-H); similarly compounds **6b** and **6c** absorbed at δ 9.58, 10.58, 10.72 and δ 9.88, 10.72, 10.80 respectively.

Furthermore, we studied the behaviour of the bis-amidoximes **12a-c** when treated with **4**, as depicted in Scheme 3. The reactions were carried out in refluxing toluene by using compounds **12** and **4** in an 1:2 molar ratio and were monitored by tlc. Compound **12a** was heated under reflux for 1 hour and the reaction mixture subjected to column chromatography to afford 4-(*p*-tolyl)-5-oxo-Δ^2-1,2,4-oxadiazoline-3-(*N*-*p*-tolyl)carboxamide *O*-ethoxycarbonyloxime **13a** (28%) and 3,3'-bis-(4-*p*-tolyl-1,2,4-oxadiazol-5-one) **14a** [4] (42%). Under similar conditions the reaction between **12b** and **4** gave compounds **13b** (31%) and **14b** (37%), whereas by treating **12c** with **4** compound **13c** (38%) was obtained. By refluxing a solution of **13a** in toluene for 12

hours the yield in **14a** was raised to 59%.

It can be assumed that the oxadiazolone rings of compounds **13** and **14** were formed *via* the *Z*-configuration of the corresponding oxanilide-*O*-ethoxycarbonyloxime precursors. This can be considered as an evidence for the anti-configuration of the starting symmetric amidoximes **12**, although their -NH-C=NOH ⇌ -N=C-NHOH tautomerization can lead to geometrical isomerizations. The anti-configuration suggested for compounds **12a-c** is in agreement with that we proposed for some other bis-amidoximes studied previously [11], as well as with the recorded ^{1}H nmr spectra of the compounds in question. In fact, these exhibit one singlet for both their =NOH protons and also one singlet for both their -NH- protons [**12a**, δ (DMSO-d_6): 2.18 (s, 6H), 6.81 (d, J = 8 Hz, 4H), 6.92 (d, J = 8 Hz, 4H), 8.37 (s, 2H, -NH-), 10.35 (s, 2H, =NOH); **12b**, 6.75 (d, J = 8 Hz, 4H), 7.12 (d, J = 8 Hz, 4H), 8.25 (s, 2H, -NH-), 10.48 (s, 2H, =NOH); **12c**, 6.82-7.36 (m, 8H), 8.21 (s, 2H, -NH-), 10.52 (s, 2H, =NOH)]. It is, furthermore, not without interest to note that the unsubstituted and the symmetrically substituted bis-hydroxyiminoquinoxalines **3a** and **3b** also show in the ^{1}H nmr spectra a similar behaviour, revealing a symmetric spatial arrangement of the -NH- and =NOH pairs in their molecules [**3a**, δ (DMSO-d_6): 6.50-6.87 (m, 2H), 6.97-7.27 (m, 2H), 9.42 (s, 2H, -NH-), 10.15 (s, 2H, =NOH); **3b**, 2.47 (s, 6H), 7.33 (s, 2H), 9.53 (s, 2H, -NH-), 10.27 (s, 2H, =NOH)].

The structure of all new compounds was confirmed by their analytical and spectral data, as given in the experimental part.

EXPERIMENTAL

Melting points were determined on a Kofler hot-stage apparatus and are uncorrected. The ^{1}H nmr spectra were recorded on a Bruker Model 80 (80 MHz) spectrometer with tetramethylsilane as internal standard. Mass spectra were determined with a Hitachi Perkin-Elmer RMU-6L spectrometer, while the ionization energy was maintained at 70 eV. The ir spectra were obtained on a Perkin-Elmer 297 spectrophotometer. Microanalyses were performed on a Perkin-Elmer 240 B CHN analyzer. Earlier reported procedures were used for the preparation of compounds **3a** [5], **3b** [9], **6a-c** [5] and **12a-c** [12].

General Procedure for the Reaction of Ethyl Chloroformate **4** with Compounds **3a-b**.

To a stirred suspension of the appropriate 2,3-bishydroxyiminoquinoxaline **3a-b** (1 mmole) in refluxing dry benzene (20 ml), ethyl chloroformate **4** (1.08 g, 10 mmoles) was added and the reaction mixture stirred under reflux until an almost complete consumption of the starting quinoxaline **3** was noticed (1.5 hour for **3a**, 3 hours for **3b**). After evaporation of the solvent, ether (20 ml) was added to the residue and the insoluble material filtered off. The filtrate was further concentrated and the residue chromatographed on silica gel with hexane/chloroform (1:1) as eluant. According to this general procedure the following products were obtained, in form of colourless crystals.

Furazano[3,4-*b*]quinoxaline **5a**.

This compound was obtained from **3a** (31 mg, 18%), mp 180-182° (lit [8] 181-182°). The yield was noticeably raised (81 mg, 47%) by increasing the reaction time up to 6 hours and allowing the 20 fold amount of **4** to react.

6,7-Dimethylfurazano[3,4-*b*]quinoxaline **5b**.

This compound was obtained from **3b** (56 mg, 28%), mp 214-217° (lit [9] 215-217°).

General Procedure for the Reaction of **4** with Compounds **6a-c**.

To a stirred suspension of the appropriate 2,3-bishydroxyiminobenzoxazine **6a-c** (3.5 mmoles) in refluxing toluene (15 ml), ethyl chloroformate **4** (460 mg, 4.2 mmoles) was added and the reaction mixture heated under reflux until almost complete consumption of the starting benzoxazine was noticed. After evaporation of the solvent, ether (25 ml) was added to the residue and the insoluble material filtered off. The filtrate was further concentrated and the residue chromatographed on silica gel with methylene chloride/ethyl acetate (1:1) as eluant. According to this general procedure the following products were obtained in form of colourless crystals.

6-Methyl-2,3-bis(ethoxycarbonyloxyimino)-2,3-dihydro-4*H*-1,4-benzoxazine **9a**.

This compound was obtained from **6a** (725 mg, 3.5 mmoles) and **4** (460 mg, 4.2 mmoles) after refluxing for 3 hours (270 mg, 22%), mp 115-117° (methylene chloride/ethyl acetate); ir (nujol): 3300, 1765, 1740 cm^{-1}; ^{1}H nmr (deuteriochloroform): δ 1.27 (t, J = 7 Hz, 3H), 1.30 (t, J = 7 Hz, 3H), 2.23 (s, 3H), 4.05 (m, 4H), 7.21-7.49 (m, 3H), 9.70 (s, 1H); ms: m/z (%) 351 (M^+, 73), 305 (100), 261 (42), 233 (63), 217 (40), 191 (29), 159 (17), 149 (64), 133 (86), 105 (94).

Anal. Calcd. for $C_{15}H_{17}N_3O_7$: C, 51.28; H, 4.88; N, 11.96. Found: C, 51.65; H, 5.07; N, 12.23.

8-Methyl-4-ethoxycarbonyloxyimino-1*H*,4*H*-[1,2,4]oxadiazolo-[3,4-*c*][1,4]benzoxazin-1-one **8a**.

This compound was also obtained from **6a** and was eluted after **9a** (192 mg, 18%), mp 235-236° (methylene chloride/ethyl acetate); ir (nujol): 1785, 1755 cm^{-1}; ^{1}H nmr (DMSO-d_6): δ 1.19 (t, J = 7 Hz, 3H), 4.21 (q, J = 7 Hz, 2H), 7.25-7.47 (m, 3H) [the 8-CH_3 peak is masked by DMSO]; ms: m/z (%) 305 (M^+, 57), 277 (19), 233 (84), 189 (42), 172 (22), 158 (36), 133 (67), 105 (100).

Anal. Calcd. for $C_{13}H_{11}N_3O_6$: C, 51.15; H, 3.63; N, 13.77. Found: C, 51.29; H, 3.49; N, 13.81.

8-Methyl-4-hydroxyimino-1*H*,4*H*-[1,2,4]oxadiazolo[3,4-*c*][1,4]-benzoxazin-1-one **7a**.

This compound was also obtained from **6a** being eluted after **9a**, **8a** (131 mg, 16%), mp 215-216° (methylene chloride/ethyl acetate); ir (nujol) 3400, 1780 cm^{-1}; ^{1}H nmr (DMSO$_6$): δ 7.15-7.52 (m, 3H), 10.61 (s, 1H) [the 8-CH_3 peak is masked by DMSO]; ms: m/z (%) 233 (M^+, 63), 217 (100), 191 (23), 189 (9), 172 (24), 158 (17), 133 (71) 118 (32), 105 (74).

Anal. Calcd. for $C_{10}H_7N_3O_4$: C, 51.51; H, 3.03; N, 18.02. Found: C, 51.84; H, 3.03; N, 17.76.

7-Methyl-2,3-bis(ethoxycarbonyloxyimino)-2,3-dihydro-4*H*-1,4-benzoxazine **9b**.

This compound was obtained from **6b** (725 mg, 3.5 mmoles) and **4** (460 mg, 4.2 mmoles) after refluxing for 4 hours (172 mg,

14%), mp 131-133° (ether/acetone); ir (nujol): 3300, 1760, 1730 cm^{-1}; ^1H nmr (deuteriochloroform): δ 1.17 (t, J = 7 Hz, 3H), 1.22 (t, J = 7 Hz, 3H), 2.36 (s, 3H), 4.25 (q, J = 7 Hz, 2H), 4.28 (q, J = 7 Hz, 2H), 7.19-7.57 (m, 3H), 9.42 (s, 1H); ms: m/z (%) 351 (M^+, 19), 305 (100), 261 (52), 233 (31), 217 (24), 189 (11), 149 (56), 118 (39), 105 (87).

Anal. Calcd. for $C_{15}H_{17}N_3O_4$: C, 51.28; H, 4.88; N, 11.96. Found: C, 51.50; H, 4.57; N, 12.14.

7-Methyl-4-ethoxycarbonyloxyimino-1*H*,4*H*-[1,2,4]oxadiazolo-[3,4-*c*][1,4]benzoxazin-1-one **8b**.

This compound was also obtained from **6b** and eluted after **9b** (246 mg, 23%), mp 182-183° (ether/acetone); ir (nujol): 1780, 1745 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.21 (t, J = 7 Hz, 3H), 2.27 (s, 3H), 4.28 (q, J = 7 Hz, 2H), 7.20-7.75 (m, 3H); ms: m/z (%) 305 (M^+, 86), 277 (27), 233 (59), 191 (52), 189 (36), 172 (24), 148 (81), 133 (38), 118 (70), 105 (100).

Anal. Calcd. for $C_{13}H_{11}N_3O_6$: C, 51.15; H, 3.63; N, 13.77. Found: C, 50.93; H, 3.89; N, 13.80.

7-Methyl-4-hydroxyimino-1*H*,4*H*-[1,2,4]oxadiazolo[3,4-*c*][1,4]-benzoxazin-1-one **7b**.

This compound was also obtained from **6b**, being eluted after **9b**, **8b** (122 mg, 15%), mp 177-179° (ether/acetone); ir (nujol): 3400, 1780 cm^{-1}; ^1H nmr (DMSO-d_6): δ 2.35 (s, 3H), 7.05-7.49 (m, 3H), 10.70 (s, 1H); ms: m/z (%) 233 (M^+, 45), 217 (78), 191 (36), 189 (27), 173 (14), 158 (73), 148 (89), 133 (46), 105 (100).

Anal. Calcd. for $C_{10}H_7N_3O_4$: C, 51.51; H, 3.03; N, 18.02. Found: C, 51.26; H, 3.14; N, 17.79.

6-Chloro-2,3-bis(ethoxycarbonyloxyimino)-2,3-dihydro-4*H*-1,4-benzoxazine **9c**.

This compound was obtained from **6c** (775 mg, 3.5 mmoles) and **4** (460 mg, 4.2 mmoles) after 5.5 hours of reflux (247 mg, 19%), mp 97-98° (chloroform/ethyl acetate); ir (nujol): 3300, 1760, 1730 cm^{-1}; ^1H nmr (deuteriochloroform): δ 1.20 (t, J = 7 Hz, 3H), 1.23 (t, J = 7 Hz, 3H), 4.25 (q, J = 7 Hz, 2H), 4.26 (q, J = 7 Hz, 2H), 7.19-7.53 (m, 3H), 9.47 (s, 1H); ms: m/z (%) 373/71 (M^+, 39), 355/53 (82), 345/43 (77), 285/33 (42), 255/53 (56), 213/11 (100), 196/94 (17), 180/78 (36), 170/68 (29), 143/41 (78).

Anal. Calcd. for $C_{14}H_{14}N_3O_7Cl$: C, 45.23; H, 3.80; N, 11.30. Found: C, 44.99; H, 4.01; N, 11.35.

8-Chloro-4-ethoxycarbonyloxyimino-1*H*,4*H*-[1,2,4]oxadiazolo-[3,4-*c*][1,4]benzoxazin-1-one **8c**.

This compound was also obtained from **6c** and was eluted after **9c** (182 mg, 16%), mp 189-192° (chloroform/ethyl acetate); ir (nujol): 1780, 1730 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.19 (t, J = 7 Hz, 3H), 4.14 (q, J = 7 Hz, 2H), 7.15-7.50 (m, 3H); ms: m/z (%) 327/25 (M^+, 46), 285/83 (13), 255/53 (46), 213/11 (38), 196/94 (24), 180/78 (22), 170/68 (81), 143/41 (67).

Anal. Calcd. for $C_{12}H_8N_3O_6Cl$: C, 44.25; H, 2.48; N, 12.90. Found: C, 43.97; H, 2.63; N, 13.01.

8-Chloro-4-hydroxyimino-1*H*,4*H*-[1,2,4]oxadiazolo[3,4-*c*][1,4]-benzoxazin-1-one **7c**.

This compound was also obtained from **6c**, being eluted after **9c**, **8c** (168 mg, 19%), mp 104-105° (chloroform/ethyl acetate); ir (nujol): 3400, 1785 cm^{-1}; ^1H nmr (DMSO-d_6): δ 7.12-7.61 (m, 3H), 10.69 (s, 1H); ms: m/z (%) 255/53 (M^+, 63), 239/37 (17), 213/11 (51), 196/94 (40), 180/78 (37), 170/68 (100), 156/54 (79), 143/41 (25).

Anal. Calcd. for $C_9H_4N_3O_4Cl$: C, 42.62; H, 1.59; N, 16.57. Found: C, 42.34; H, 1.79; N, 16.32.

General Procedure for the Reaction of **4** with Compounds **12a-c**.

To a stirred suspension of the appropriate bis-amidoxime **12a-c** (5 mmoles) in refluxing toluene (15 ml) ethyl chloroformate **4** (1.080 g, 10 mmoles) was added and the reaction mixture refluxed for about 3 hours. After evaporation of the solvent, ether (25 ml) was added to the residue and any insoluble material filtered off. The filtrate was further concentrated and the residue chromatographed on silica gel with chloroform as eluant. According to this general procedure the following products were obtained as colourless crystals.

3,3'-Bis(4-*p*-tolyl-1,2,4-oxadiazol-5-one) **14a**.

This compound was obtained from **12a** (1.49 g, 5 mmoles) and **4** (1.080 g, 10 mmoles) (0.73 g, 42%), mp 261-263° (ether); ir (nujol): 1770 cm^{-1}; ^1H nmr (DMSO-d_6): δ 2.32 (s, 6H), 7.12-7.51 (m, 8H); ms: m/z (%) 350 (M^+, 39), 308 (46), 306 (28), 261 (74), 247 (51), 201 (62), 156 (100), 149 (72), 131 (89).

Anal. Calcd. for $C_{18}H_{14}N_4O_4$: C, 61.71; H, 4.03; N, 16.00. Found: C, 61.83; H, 4.08; N, 16.09.

4-(*p*-Tolyl)-5-oxo-Δ^2-1,2,4-oxadiazoline-3-(*N*-*p*-tolyl)carboxamide *O*-Ethoxycarbonyloxime **13a**.

This compound was also obtained from **12a** and was eluted after **14a** (0.56 g, 28%), mp 150-151° (ether); ir (nujol): 3300, 1780, 1760 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.31 (t, J = 7 Hz, 3H), 2.30 (s, 3H), 2.36 (s, 3H), 4.20 (q, J = 7 Hz, 2H), 7.13-7.44 (m, 8H), 8.14 (s, 1H); ms: m/z (%) 396 (M^+, 19), 350 (42), 324 (12), 306 (37), 261 (80), 247 (71), 201 (39), 156 (89), 149 (100), 133 (83).

Anal. Calcd. for $C_{20}H_{20}N_4O_5$: C, 60.60; H, 5.09; N, 14.14. Found: C, 60.31; H, 5.21; N, 13.98.

3,3'-Bis[4-(4-chlorophenyl)-1,2,4-oxadiazol-5-one] **14b**.

This compound was obtained from **12b** (1.685 g, 5 mmoles) and **4** (1.080 g, 10 mmoles) (0.72 g, 37%), mp 295-296° (ether); ir (nujol): 1790 cm^{-1}; ^1H nmr (DMSO-d_6): δ 7.06-7.53 (m); ms: m/z (%) 392/90 (M^+, 14), 351/49 (19), 350/48 (62), 335/33 (81), 309/307 (56), 225/23 (19), 155/53 (39), 154/52 (46), 127/25 (100), 113/11 (84).

Anal. Calcd. for $C_{16}H_8N_4O_4Cl_2$: C, 49.12; H, 2.06; N, 14.32. Found: C, 49.24; H, 2.39; N, 14.35.

4-(4-Chlorophenyl)-5-oxo-Δ^2-1,2,4-oxadiazoline-3-(*N*-4-chlorophenyl)carboxamide *O*-Ethoxycarbonyloxime **13b**.

This compound was also obtained from **12b**, being eluted after **13b** (0.68 g, 31%), mp 166-168° (ether); ir (nujol): 3300, 1790, 1760 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.23 (t, J = 7 Hz, 3H), 4.26 (q, J = 7 Hz, 2H), 7.05-7.49 (m, 8H), 8.39 (s, 1H); ms: m/z (%) 438/36 (M^+, 22), 410/408 (9), 392/90 (25), 357/55 (16), 304/302 (19), 269/67 (54), 223/21 (21), 179/77 (16), 155/53 (39), 139/37 (71), 129/27 (42), 127/25 (100), 113/11 (29).

Anal. Calcd. for $C_{18}H_{14}N_4O_5Cl_2$: C, 49.44; H, 3.23; N, 12.81. Found: C, 49.16; H, 2.89; N, 12.61.

4-(2-Chlorophenyl)-5-oxo-Δ^2-1,2,4-oxadiazoline-3-(*N*-2-chlorophenyl)carboxamide *O*-Ethoxycarbonyloxime **13c**.

This compound was obtained as the sole product of the reaction of **12c** with **4** (0.74 g, 34%), mp 109-112° (ether); ir (nujol): 3300, 1785, 1750 cm^{-1}; ^1H nmr (DMSO-d_6): δ 1.32 (t, J = 7 Hz, 3H), 4.30 (q, J = 7 Hz, 2H), 7.04-7.52 (m, 8H), 8.41 (s, 1H); ms: m/z (%) 438/36 (M^+, 17), 410/408 (11), 392/90 (31), 350/48 (21), 319/17 (62), 291/89 (46), 242/40 (23), 211 (39), 155/53 (74), 154/52 (26),

129/27 (82), 113/11 (100).

Anal. Calcd. for $C_{18}H_{14}N_4O_5Cl_2$: C, 49.44; H, 3.23; N, 12.81. Found: C, 49.29; H, 3.05; N, 13.03.

REFERENCES AND NOTES

[1] T. Bacchetti and A. Alemagna, *Atti Acad. Nazl. Lincei, Rend., Classe Sci. Fis. Mat. Nat.*, **22**, 637 (1957); *Chem. Abstr.*, **52**, 15111 (1958).

[2] J. H. Boyer and P. J. A. Frints, *J. Heterocyclic Chem.*, **7**, 59 (1970).

[3] R. Ün and D. Sümengen, *Chim. Acta Turc.*, **4**, 131 (1976).

[4] T. Bacchetti and A. Alemagna, *Atti Acad. Nazl. Lincei, Rend., Classe Sci. Fis. Mat. Nat.*, **28**, 824 (1960); *Chem. Abstr.*, **56**, 7304 (1962).

[5] N. E. Alexandrou and D. N. Nicolaides, *J. Chem. Soc. (C)*, 2319 (1969).

[6] C. V. R. Sastry, M. Jogibhukta, V. S. H. Krishnan, S. P. Rao, K. Vemana, D. R. Shridhar, R. M. Tripath, R. K. Verma and R. Kaushal, *Indian J. Chem. Sect. B*, **27**, 1110 (1988).

[7] C. V. R. Sastry, V. S. H. Krishnan, G. K. A. S. Narayan and K. Vemana, *Chem. Ind. (London)*, 227 (1989).

[8] D. N. Nicolaides and J. K. Gallos, *Synthesis*, 638 (1981).

[9] N. G. Argyropoulos, J. K. Gallos and D. N. Nicolaides, *Tetrahedron*, **42**, 3631 (1986).

[10] Y. Gök and S. Serin, *Synth. React. Inorg. Met.-Org. Chem.*, **18**, 975 (1988).

[11] D. N. Nicolaides, K. E. Litinas and I. Naidou, *Chim. Chro. New Ser.*, **11**, 73 (1982).

[12] N. E. Alexandrou and D. N. Nicolaides, Report of the Fourth Conference of the Greek Chemists, Athens 1970, p 39; *Chem. Abstr.*, **85**, 77826 (1976).